

STRATEGY
RESEARCH
PROJECT

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**ARMING THE FUTURE ARMY – AMMUNITION SUPPORT
FOR THE ARMY AFTER NEXT**

BY

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USAWC STRATEGY RESEARCH PROJECT

**Arming the Future Army - Ammunition Support for the
Army After Next**

by

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ABSTRACT

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This SRP examines the key issues the Army must address as it looks to arming the Army After Next (AAN). With rising operational tempo (OPTEMPO) and associated Operations and Maintenance (O&M) costs; and nearly constant funding at or below inflation, the Army's logistics tail is no longer affordable. As our combat platforms age and the Research and Development (R&D) funds diminish, more cost efficiencies and technological advancements must be realized. Army leadership realizes that in order to transition to the AAN, there must be a Revolution in Military Logistics (RML). In order to revolutionize how the Army arms itself, there are several key issues that must be addressed. Those issues include reducing costs to produce and maintain ammunition, advancements in technology, distribution, doctrine, and smarter business practices. This SRP will address each of these basic issues and highlight what must take place in ammunition sustainment to meet the challenges of the Army's transition from an Army of Excellence to the Army After Next.

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ARMING THE FUTURE ARMY - AMMUNITION SUPPORT FOR THE ARMY AFTER NEXT

"A Revolution in Military Logistics: Changing logistics in support of a power projection Army by reshaping the way we project and sustain...Right stuff, right place, right time...always at best value!"

— LTG John G. Coburn
US Army Deputy Chief of
Staff for Logistics

As the Army looks to the future, its vision to be the best in the world requires a full spectrum force. This force, an integral part of a joint team, must be equipped with the most modern weapons and equipment our nation can provide. That force must be able to respond to our call for readiness from a full range of contingencies that include anything from a Major Theater War (MTW) to any Major Operation Other Than War (MOOTW), from humanitarian assistance to peace keeping anywhere about the globe. This force must be able to change to meet the challenges of today, tomorrow, and into the 21st Century.

The Army's needs are changing. Today's Army is smaller, more lethal, under an ever increasing OPTEMPO, and part of a power projection force strategically placed around the globe. As we head into the Army XXI, we will need information dominance, a revolution in our business affairs, and an increase in technology insertion. This spectrum of rapid technology change

will be weighed facing risks of reduced DOD budgets. There are certainly tough decisions to be made between new technology and maintaining operational readiness and training. At the same time our force structure is about 58% of what it was during DESERT STORM, it is operationally more engaged by a factor of three. This means maintaining best value systems and support structures and ensuring our core competencies are solid.

The Army After Next must use leap ahead technology, global real-time logistics control, and anticipatory and precision logistics. This prescription is expected to produce yet a more lethal Army at reduced costs. To take the Army into this herculean transition period, a Revolution in Military Affairs is required. As the Chief of Staff, US Army put it, "You can not have a Revolution in Military Affairs without having a Revolution in Military Logistics".¹

In fact, the Revolution in Military Logistics has already begun. To ultimately revolutionize logistics, we must replace mass and redundancy with velocity and precision. We must transform location and distribution systems through better use of information technology. Lethal more speedy combat forces will require streamlining organizations. System life cycle costs must be reduced with continuous improvement in reliability and sustainability. In short, this revolution is the fulcrum of the Army's effort to balance readiness and modernization. It

will require a cultural change in our logistics vision. A vision which means "a Revolution in Military Logistics leveraging technology to fuse new concepts, information, and logistics systems, reshaping the way we project and sustain America's Army in the 21st Century".²

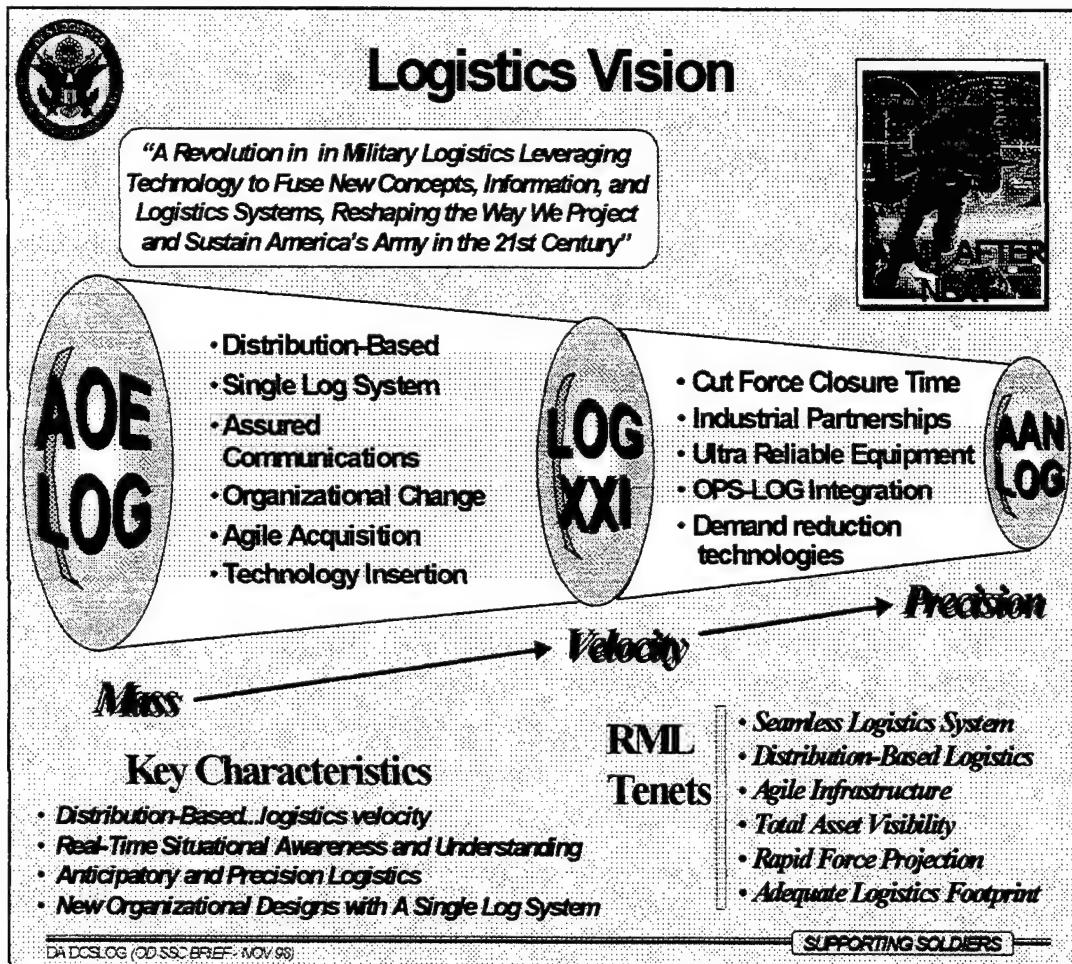


Figure 1. AMC Munitions Update. 9-15-98

The figure above illustrates the DCSLOG's logistics vision for the Army; as it transitions from the Army of Excellence to

the Force XXI, and on to the Army After Next. What it symbolizes is the transitional changes in "Focused Logistics" that are currently ongoing to take us to Force XXI and beyond. Logistics of the future will certainly not have the redundancy seen by massive stockpiles used in the 1980's and early 1990's. We have begun our transition to a distribution-based logistics system. Assured communications, more agile acquisition strategies, and use of technology insertion with already proven off-the-shelf non-developmental items (NDI) have seen many early success stories.

Key characteristics of the transition include a distribution based logistics system that increases logistics velocity by passing previous levels of support, use of strategic, mission and unit configured loads, and absolute minimal handling of equipment and supplies. The logistics infrastructure must have a real-time situational awareness utilizing better diagnostics/prognostics, a common operating practice and in-transit visibility. New organizational designs will mean an agile logistics structure with tailored force packages who can operate split based with minimal stockpiles and new maintenance concepts.

This Revolution in Military Logistics (RML) means at the operational and tactical level there are key characteristics that represent empirical changes that trade mass for velocity

with precision focus that gets distribution based logistics from the depot to the foxhole. The RML tenants of an AAN as seen in Figure 1 are:

- seamless logistics system
- distribution based
- agile infrastructure
- total asset visibility
- rapid force projection
- adequate (smaller) logistics footprint

This means placing a smaller, yet more lethal fighting force with reduced closure time. It will require smarter industrial partnerships to use technology that's already working in the civilian sector for more practical military applications. It means fielding ultra reliable equipment. It dictates a closer operational logistics integration than ever before with demand reduction technologies that can make new, more sophisticated weapons systems even more supportable at a price we can afford.

So what does all this RML mean for arming the AAN? In every key RML tenant above, Class V support must realize several key changes for ammunition sustainment in the 21st Century. In particular, these changes will have a major impact in reducing overall sustainment costs; velocity management to cut force and sustainment closure time; more reliable/survivable assets; renewed partnership with the industrial bases to ensure we

maintain our technological lead; and developmental and integrated changes across doctrine, training, leader development, organizations, materiel, and soldiers (DTLOMS) to increase weapons sustainment by using the best trained and lethal force on the globe.

In the sections that follow, we will take a deeper look at just what is being done today to reduce ammunition costs. We will survey what's being done in our acquisition and sustainment programs to get best value and reduce life cycle cost management. We will take a look at our new technological applications to be more lethal and maintainable, yet reduce the huge logistics footprint commonly associated with Class V. Next, a look at the industrial base for efficiencies in both production and sustainment operations. Last we look across the entire DTLOMS spectrum to find out where all these changes in a RML impacts Class V support for the future.

ASSUMPTIONS

In order comply with the National Military Strategy (NMS), the Army must generate, deploy, and sustain forces capable of rapid, decisive victory across the operational continuum.

Military operations in today's environment require the ability to tailor logistics packages to meet operational and tactical requirements in hours or days... Our efficient use of these systems produces a smaller logistics tail that reduces the burden on transportation systems, requires fewer resources to

defend, and is more difficult for the enemy to detect, and enhances our mobility.³

Operations such as URGENT FURY, JUST CAUSE, DESERT SHIELD/DESERT STORM and RESTORE HOPE have demonstrated the Army's ability to deploy when required. However, they also

underscore the deficiencies of a logistical support scheme that must be as responsive and capable as the force it supports...the Army will be increasingly called upon to provide sustainment operations in a joint, multinational and interagency environments.⁴

In sum, as the Army develops towards Force XXI and the AAN it must be able to accommodate the challenges of a new strategic and operational environment. Under this premise, there are some underlying assumptions as the Army looks to "arm" with a future logistics system:

- The system must be able to support full dimensional operations and force design that cover the gamut from operations in war to other operations such as peacekeeping, disaster relief, and humanitarian support.
- "Strategic planning guidance will continue to articulate a power projection strategy, to maintain a limited overseas presence, and to require Department of Defense (DOD) participation in major regional contingencies."⁵
- The Army will remain the DOD proponent for support of ammunition for ground operations.

- "Technology advancements will allow for greater dispersion of operations. The information age will be eclipsed by the beginning of another new age."⁶
- An increased amount of partnering with industry will realize and even greater number of government and contractor civilian providing combat service support (CSS) in a theater of operations.
- "Overall, we can expect the sum of the Army's logistics capabilities will be less than the sum of the Army's logistics requirements."⁷

LIMITATIONS

Successful long-term implementation of a vision for arming the AAN will be contingent upon the automation and modernization of as many functions as possible. This takes time and a long-term investment strategy at a time when aging munitions drastically need renovations and technological advancement. That takes resources. It will be necessary to invest in continued growth in total asset visibility, in transit visibility, situational awareness and split based operations. It means resourcing a system that provides visibility of physical assets during manufacturing, in storage, in transit and on hand.

- It means paying for a new seamless logistics pipeline that virtually eliminates the current wholesale and

retail sections, and incorporates the full scope of all military services, the industrial base, DOD civilians, civilian contractors, and private industry.⁸

These ideas all cost resources in a time when new funding is extremely challenged.

AMMUNITION FUNDING

A review of the current funding profiles for ammunition show some alarming trends. At times when the Army's OPTEMPO and deployment status is over 300% higher than during DESERT SHIELD/DESERT STORM, the procurement dollars made available by Congress is far less by comparison.

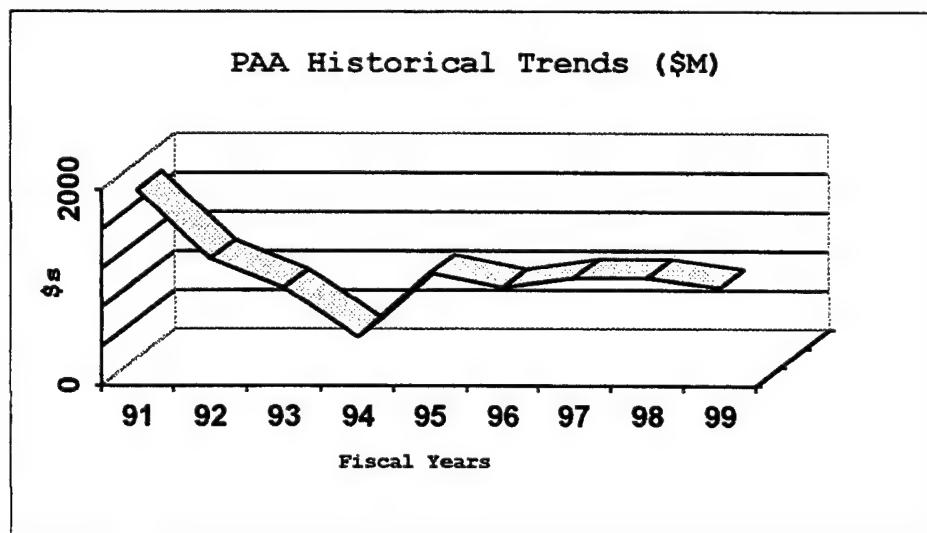


Figure 2, AMC Munitions Update, 9-15-98

What the figure clearly indicates is little to no funding increased, yet the OPTEMPO since 1991 has increased over 300%.

The next two illustrations show FY98 and FY99 appropriations for ammunition and that appropriation as a percentage of the procurement budget for FY98 and FY99.

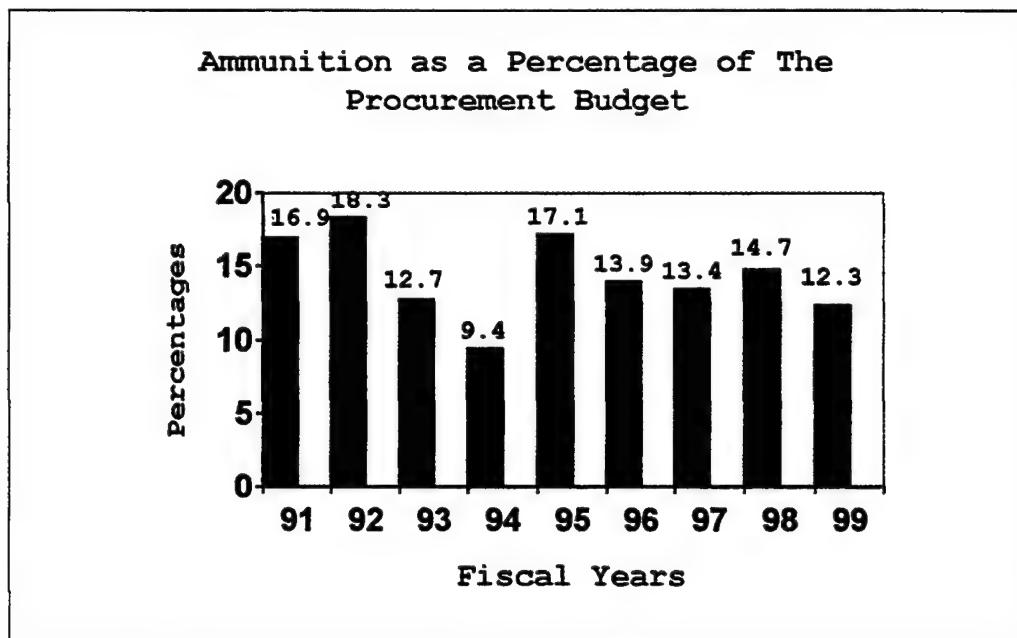


Figure 3, AMC Munitions Update, 9-15-98

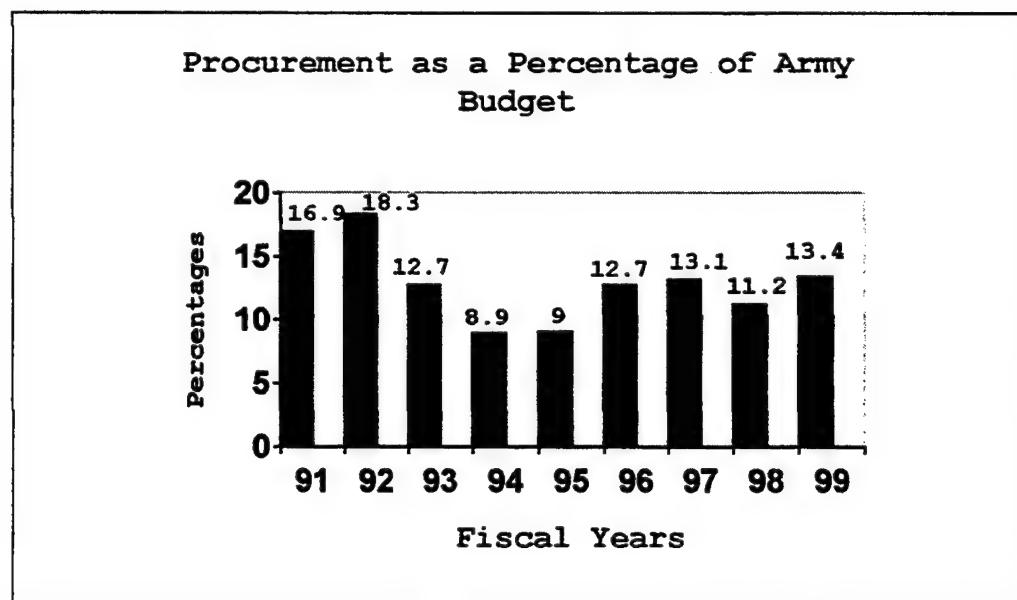


Figure 4, AMC Munitions Update, 9-15-98

Although the drop in ammunition procurement was only \$11 million and missiles received a \$462 million plus up, the bar chart in Figure 3 reflects a 2.4% reduction in overall procurements since last FY, and rates second lowest in the period shown.

What also further widens the spending gap is the challenge of how to spend what does get funded. There has been a continual challenge of funding the production base versus hardware. Increases in funding to maintain industrial facilities, layaway or "mothball" unrequired facilities, and demilitarization (demil) requirements for ammunition represent over 97% of the PAA Funding for FY99. Each year the amount of ammunition which becomes obsolescent or becomes unsafe to fire over troops gets larger. Each year, the costs associated with disposal or demil becomes increasingly higher. As EPA controls from state to state become more stringent in lieu of environmental concerns, there are less places the Army can actually perform the demil operations. Since 1996, the cost of demil operations per ton of ammunition has dramatically risen. Table 1 below depicts the cost increase for demil.

Ammunition Demilitarization Cost		
<u>FY</u>	<u>Cost per Short Ton</u>	<u>% Increase</u>
96	\$580	-
97	\$864	48.9
98	\$1,001	72.6

Table 1, AMC Munitions Update, 9-15-98

Funding for demil in the same period has likewise required a dramatic increase, yet falls short of the required funding goals in the last four years representative of this period. Figure 5 below depicts this trend.

Demil Funding by Fiscal Year

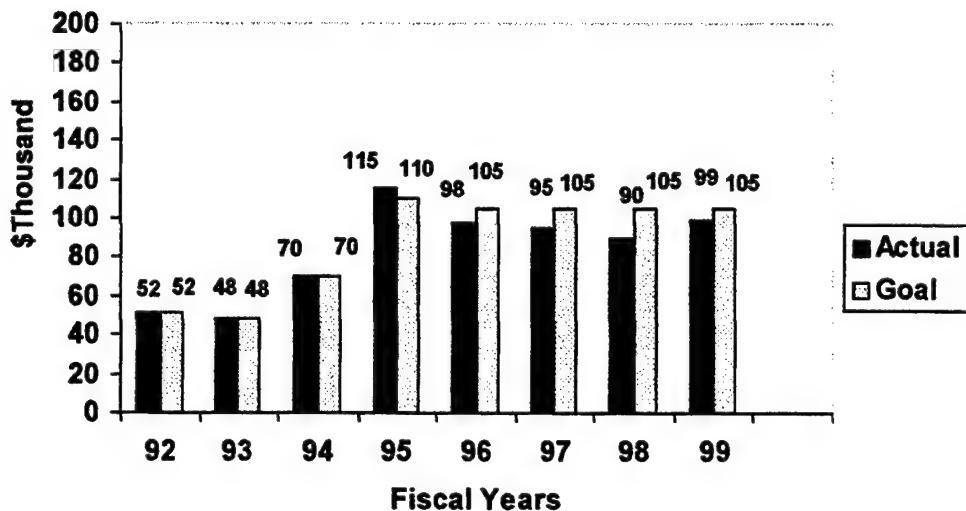


Figure 5, AMC Munitions Update, 9-15-98

What's worse, is that although the requirement seems to have leveled off around \$100 million each FY, there are many aging

artillery and tank rounds that are in the active inventory that are growing old and deemed unsafe, or simply have no more combat platforms in the active Army or reserve components to fire them. There are literally hundreds of millions of 105mm tank and artillery rounds as well as the old 8" artillery munitions which are obsolete in our requirements, and therefore a demil candidate for the future.

To meet these ever increasing demil requirements, the Army has set some goals to help keep funding at a manageable level. First, "continued cost avoidance through direct sales, FMS, cross-lending between services and use in training wherever possible."⁹ Examples of this initiative can be seen in FMS cases between the US Army and the Republic of Korea Army (ROKA) for 8" artillery, 105mm tank and artillery rounds. In FY99 alone, the United States raised its congressional limits from approximately \$30 million in annual sales to over \$300 million to facilitate this cost reduction increase. Secondly, "execute a balanced program between destructive and non-destructive technologies."¹⁰

This initiative ensures that in future years cost per ton in demil will be dramatically reduced by ensuring technologies like combustible ordnance components are the way of the future. Items that support this initiative include partnering with industry to make items such as 155mm artillery charge components, combustible casings for 152mm and 120mm tank

ammunition, and incremental propellant containers for 51mm, 60mm, 81mm, and 120mm mortar rounds. "As a result of this and several other cooperative efforts with DOD engineering and procurement agencies, ARMTEC is the only supplier of combustible ordnance products to the US government."¹¹ Combustible ordnance products and other advanced technological developments will be sited in another section. And last, maintain a balance between government installations and the growing private industry capabilities. This too will be addressed further in the "Industrial Base" section of this paper.

Another resource trend, which has Army budget personnel as well as the operational units in the field troubled, is that of training ammunition. The trend since FY85 has been to fund less of training ammunition requirements by actual procurement and more with drawdown from our country's war reserve stockpile. Table 2 reflects this trend as well as a reversal of training ammunition procurement dollars required in the out years.

Training Ammunition Resource Trend					
FY	Total Tng Ammo \$ Procurement	Actual \$ Procurement	% Total	War Reserve Drawdown	% War Reserve Used
85	\$1.2B	\$1.04B	86.6%	\$.18B	13.4%
90	\$1.1B	\$0.80B	72.7%	\$.30B	17.3%
95	\$1.0B	\$0.60B	60.0%	\$.40B	40.0%

FY	Total Tng Ammo \$ Procurement	Actual \$ Procurement	% Total	War Reserve Drawdown	% War Reserve Used
00	\$0.95B	\$0.70B	73.6%	\$.25B	26.4%
05	\$0.90B	\$0.90B	100%	\$-0-	-0-
01	\$0.90B	\$0.90B	100%	\$-0-	-0-

Table 2, AMC Munitions Update, 9-15-98

What the Table above reflects is that although we were able to live off the "fat" of our war reserve stocks for as much as 40% of our training ammunition procurement, the age of that stockpile and its actual depletion over the last 10 years (1985-1995) has meant less available today for sustainment of Army training - a cost that will surely increase with the war reserve drawdown ending, modernization of the force structure, and increased costs of materials. This is a trend that will require substantial plus ups in the training ammunition account if the Army is to maintain trained and combat ready forces.

Additionally, as the Army remains the executive agent for ammunition in DOD, all services will feel the impact of increased training ammunition costs in the future.

With rising costs projected, the keystone to future ammunition supply and resupply will be a combination of improvements in our munitions technology, their application, improvements in the industrial base, and the knowledge based

distribution and employment of those assets from depot to foxhole. The imperatives to reducing costs of ammunition lie in its production, storage/maintenance, and demilitarization. Our ability to maintain ammunition readiness lies in our replenishment capability and ability to produce future AAN requirements in the industrial base, which is our next focus.

TECHNOLOGIES

In its concept of future joint operations, "JV 2010" states:

aware of the current technological revolution, the military should recognize that ultimately, success results from technological advances and innovative ways of considering and combining them for warfighting. Undoubtedly, improving legacy systems and employing them in new and efficient ways will have a place in the world of JV 2010.¹²

Our military clearly will have to integrate emerging technological advancements with innovative thinking as it tries to gain new warfighting capabilities. Technological innovation is one of the two "key enablers" presented in JV 2010 and our AAN strategy. Technological developments in ammunition will have a tremendous impact on our military operations in the future. Even though the investment in defense technology declines because of budgetary constraints, we will be forced in the future to "locate high-value, time-sensitive, fixed and mobile targets and to destroy them with a high degree of confidence - a fundamental change in the conduct of war."¹³ As

we look to the technology of the future, we know that in order to engage the threats use of asymmetric strategies, we need munitions that have improved capabilities, fire longer distances, have high lethality rates, greater accuracy, and are easier to support.

Technology in munitions must allow units to be more widely dispersed, lighter more agile, increasingly lethal, and has smaller "footprints". "Key technological areas in JV 2010 and AAN concepts include use of low-observable/masking technologies, smarter weapons, long-range precision capability and fusion of information technology."¹⁴ This use of high tech munitions with weapons employed to mass fires at critical points and time in space, now offer the potential for continuous offensive operations. In his look into the future, Doug Macgregor, author of "Breaking the Phalanx" states:

In the early phases of future war, precision guided missile/munitions will play a decisive role in the effort to gain and retain the initiative. Carefully timed mass strikes will paralyze large ground and air forces in the theater of war that are dependent on fixed installation for frequent refueling and resupply. The vulnerability of static ground forces to mass strikes creates the incentive for military leaders to conduct high-speed ground offensive to strike deep into enemy territory. In sum, the effects of US forces will be to extend the depth of warfare further using lethal, precision-guided munitions launched at still greater ranges beyond the visual range of the enemy comprising rear, close, and deep combat operations into one continuous fight.¹⁵

As the logisticians in the Army look for ways to make the most of their research and development effort, there are two key areas where leveraging technology will produce the biggest bang for the diminishing dollar. Precision munitions and logistics enablers in sustainment and maintenance are the answer. Why is it precision munitions that the senior leaders target for investment? The reason is that when the Army reviewed just what makes up its CSS tonnage, it found that all munitions "comprise approximately 70% of the CSS tonnage. Of that, 80% of Class V is artillery munitions. Therefore, the opportunity exists for technology advancement in artillery precision munitions to impact 56% of CSS tonnage."¹⁶

This advance in technology represents a significant ability to reduce the ammunition logistics footprint. The AAN project is focused on speed with respect to strategic deployability and tactical dimensions. Reducing the logistics tail improves the strategic deployability to the AAN, making the land force component of any early response part of a more rapid power projection based force.

Logistics - in all its dimensions - particularly Class V sustainment will impact the speed of the force. Therefore, technologies that enable the force to move faster, lighten itself, and move with drastically reduced logistics support will be critical.¹⁷

In fielding a new era of fighting forces for the AAN, "shrinking the logistics tail to the theater of operations and on the battlefield itself is a fundamental goal."¹⁸

To begin an interactive process in its development of precision munitions, the Precision Munitions/Logistics Study (PMLS) was founded. The Study sponsors for the PMLS consist of the Commanding Generals (CGs) of Army Materiel Command (AMC), Training and Doctrine Command (TRADOC), and the Department of the Army, Deputy Chief of Staff Logistics (DA DCSLOG). The PMLS organization represents a fully integrated business approach to solving tomorrow's problems today. The PMLS has study advisory groups co-chaired by AMC-DCS Ammo and the TRADOC Assistant DSC Combat Development, as well as special study groups within AMC and other DOD agencies. These teams of subject matter experts are connected by a fully integrated data environment using best commercial business practices to best integrate engineering, logistics, and cost decisions. By doing so, "the PMLS organization has a corporate management structure for which the organizing principle is multifunctional work teams or Integration Process Teams (IPTs)."¹⁹ The PMLS uses a decentralized structure with integrated data to come up with data that can be transformed into actionable information. This means as a munition is being studied, its information is handled

more efficiently and fully integrated into business operations at a reduced cost.

In studying the best application for precision munitions, the PMLS looked at the given warfighter strategies for both Force XXI and AAN. They considered all the logistics impacts that result in the use of precision munitions versus the use of non-precision munitions only. Given these logistics impacts, what are the resulting implications on an Army Force Modernization effort and Army Force Compositions? Once those were outlined, what are the costs? The group also had to look into the second and third order effects of determining the true burdens (deltas in logistics) of precision versus non-precision munitions. What would be the impact across all combat, combat support, and CSS force structure and what are the costs? Then, given a scenario ranging from a full MTW to MOOTW, determine the optimal weapons mix, level of investment, and then compare that sustainment costs for a realistic mix of precision and non-precision munitions.

In performing the study, the IPTs were able to "quantify cost of ownership/burden to the Army between current non-precision and future precision munitions across the total logistics footprint and in battlefield performance."²⁰ Next, they were to draw from previous and ongoing studies to determine warfighting effectiveness and logistics sustainability. The

task here will be to identify and quantify the value between conventional and precision munitions. This year, the PMLS is scheduled to provide data, findings and conclusions, and recommendation for decision-makers for the POM 02-07 process.

Figure 6 represents the most recent PMLS Conventional and Precision Munitions candidates for which 12 items were studied.

PMLS Conventional and Precision Munition Candidates (12)			
Target Description	Current/Conventional Munition	Next Generation Precision Munition	PMLS Comments/ Benefits
Bunkers, soft targets	Bunker Defeat Munition	PGMM, 120mm	Provides urban combat capability, extends range and precision
Anti-armor	Family of 120mm tank main gun ammo	Tank extended range munition TERM	Increased survivability by engaging targets in defilade
All targets	155mm, DPICM base bleed, M864	ER XM982 DPICM, SADARM	Improves range for counter battery
Bunkers	155mm, HE widelay fuze	ER XM983 HE delayed fuze	Bunker engagement
Counter Battery	155mm, DPICM	XM898 PI SADARM	More efficient counter battery killer
All targets	155mm, DPICM	155mm, Low Cost Competent Munition (LCCM) Fuze GPS on M864 / M483	Provides accurate registration Improves target engagement Reduces munition requirements
All targets but heavy armor	MLRS DPICM, XM85	MLRS DPICM Extended range with GPS guidance	Extends range and significantly improves accuracy

Continued on next page

Target Description	Current/Conventional Munition	Next Generation Precision Munition	PMLS Comments/Benefits
Anti-armor	No current indirect rocket launched capability	MLRS MSTAR	MSTAR kills ACV targets deeper, Diminishes intensity of close fight, Improves force survivability
All targets but heavy armor	ATACMS APAM	ATACMS IA GPS	Accuracy independent of range
Anti-armor and High Value targets	No current indirect missile launched deep capability	ATACMS II / BAT P31	Kills High Value targets deep, improves force survivability
Soft point targets and bunkers	Hydra 70, and sometimes Hellfire II (LSA)	Advanced Precision Kill Weapon System (APKWS) (LSA)	Reduces rocket requirements, Reduces collateral damage
Heavy armor targets and threat air defense systems	Hellfire II (LSA)	Apache Longbow (MMW)	Enhanced platform survivability, Provides all weather capability

Figure 6, AMC Munitions Update, 9-15-98

Based on the study shown on these 12 candidates, there were several key benefits realized by utilizing precision munitions. They included increasing warfighter survivability due to greater stand off or defilade firing capability. Increased accuracy and lethality reduced a significant amount of munitions required for sustainment and initial combat load. When PMLS can engage and kill high value targets deeper, overall force survivability increases.

In another artillery development, PM ARMS has taken a leap-ahead approved in developing combat power for tomorrow's warfighter. Teaming together with both US and International allies, they have developed an overarching strategy called the Family Life Cycle Strategy. The purpose of this new family of munition strategy is to provide integrated life cycle management and acquisition planning for the family of cannon artillery.

The goals of the new strategy included the following:

Develop and implement the most comprehensive and cost effective approach to the Army for the life cycle management of cannon artillery munitions. An initial goal to reduce total ownership cost for this family by a minimum of 5% per year. Other goals include better recover of asset value and reutilization of funds. Provide the finest cannon artillery munitions support and leap-ahead munition combat power using the most cost efficient means. Apply lessons learned with other PMLS IPTs. Programs will cover 105mm, 155mm, and 8-inch cannon munitions.²¹

The results thus far look promising. Using 30% fewer projectiles required previously, reduced submunition cost by 22% and enlarging the footprint of the kill area by three items.

When asked how this template would be applied to future technological advancements, PM ARMS reflected that by 2010 artillery projectiles range will have a maximum range over 50 kilometers (currently 17.9 - 22.5 km) and use Global Positioning System (GPS) to increase accuracy. These smart munitions will be able to process from 2800 bytes to 28,000 bytes in roughly a 750 milliseconds time period when data can be used for mid-

course trajectory correction. Once again, the results will optimize key performance parameters, reduced crew handling and logistics, and enhance additional performance perimeters with higher reliability.

Another major breakthrough in technology has been the development of the Modular Artillery Charge Systems (MACS). Under this new development, all current propellant charges used in the Army and Marine Corps artillery munitions would be replaced. Currently, artillery systems use bag propellant charges. Under the new MACS only two solid propellant charges are used. The result is increased operational capability, increased range of another 10km and the ability to shoot multiround simultaneous increment missions with increased accuracy. But, the real focus of the MACS has been what it means in terms of ammunition logistics and sustainment systems, namely:

conservative estimates for use during an MRC requirement mean a 40% reduction in cube space impacting container and transportation. A 10% reduction in weight will have similar favorable sustainment effects as well as improved upload/download rates for configured loads to the customer.²²

What does this mean in terms of cost? With reduced weight, cube, and easier handling characteristics, the total life cycle costs for receipt, storage, issue, and throughput to user will be less. This propellant is scheduled to be utilized in

conjunction with the new CRUSADER fieldings in the FY99-FY02 time frame.

New technologies for artillery munitions using a total system life cycle approach will provide even greater logistics breakthroughs. Some day, munitions will use embedded ID microchip and temperature sensors. This will be used as a double check in the CRUSADER Autoloader System to verify what the system has actually uploaded is what the weapon is ready to fire. Improved packaging for insensitive munitions will enhance crew survivability. With chip technology, not only total asset visibility, but accountability by increment will be available in a supply data base. It has been speculated that with imbedded chip technology, resupply can be scheduled for when crews need the ammunition versus pushing huge unused stockpiles to carry around the battlefield. This would be just another example of ensuring the tenant of adequate logistics footprint is more than just doing more with less.

Within the Tank-Automotive and Armament Command (TACOM), there is an organization known as the US Army Defense Ammunition Logistics Activity. This team of teams often referred to as "AMMOLOG" has the charter to "develop the logistics technologies that will maximize munitions availability (ammunition and missiles) to our Force XXI and Army After Next forces through strategic, operational, and tactical continuum."²³

The major thrust of AMMOLOG is to ensure the land force dominance through survivable power projection logistics. Within this focus, AMMOLOG has identified five specific areas in order to improve and integrate the "lab to gun" ammo logistics systems for overwhelming firepower. They are Battlefield Rearmament; Ammunition Packaging, Logistics C4 for Ammo, CSS, and Explosive Safety. Under this program, AMMOLOG incorporates a number of smaller projects that are often lost in the acquisition system. However, together these projects can dramatically enhance the logistical force protection and ensure support for critical munitions assets by "reducing weapon systems rearm times, applying state-of-the-art technologies to improve ammo packaging, enhancement of explosive safety, and improving strategic and battlefield distribution."²⁴

Examples of AMMOLOG's impact on the Army After Next include the Artillery Ream Module (ARM) II technology which uses a mechanical reload for 155mm artillery munitions to the new CRUSADER System. Logistics C4 for ammo has seen the increased use of CD-ROM with a program called the Ammunition Surveillance Information System (ASIS). This technological development has reduced the technical library in most units from hundreds of linear feet of reference publications to one PC Laptop with CD-ROM drive. It has also dramatically reduced workload in ammunition units for both stock accountability and surveillance

sections because of its interface with the Standard Army Ammunition System - Modified (SAAS-MOD). In explosive safety, ammo stored in MILVANS, has reduced the Hazard Zone from 1200 feet to 360 feet. Ammo repackaging initiatives have reduced the M1A1 tank reload from 33 minutes to 13 minutes for resupply of a turret load of 120mm munitions. This advance alone has netted savings of \$17 million through FY96.

MUNITIONS SURVIVABILITY PROBLEM

As technology increases, not just US potential increases in the area of preferred munitions. Our enemies will also have the capability and intent to destroy munitions at insertion points such as APOD, SPODS, Theater and Corps Storage Areas. Usually, because of explosive weight considerations, spare and resource constraints lead to storage of Class V in high-density stockpiles. These munitions nodes are very vulnerable to espionage attacks providing the enemy extremely lucrative targets. This means a high potential loss of critical preferred munitions. Most CINC plans are keyed to limited preferred munitions. For example, 1½ MILVAN containers of SADARMs is the total basic load for one artillery battalion. Clearly, "challenges of future warfare will be short, quickly decided battles; reduced logistics tail; just in time delivery; and the enemy's ability to access smart munitions."²⁵

In developing munitions survivability programs, AMMOLOG has partnered with the Industrial Operations command (IOC), Picatinny Arsenal, Aviation Missile Command (AMCOM), and Combined Arms Service Support Command (CASCOM) to look at ways to improve ammo packaging development of insensitive munitions. In its ammo packaging development, AMMOLOG is trying to use new materiels, designed and embedded sensors to "ensure ammo longevity the next 30 years while at the same time trying to lower the overall life cycle costs by 1-2%."²⁶ Technology improvement in advanced containers hopes to achieve reduced life cycle costs by reducing the items weight and cube while using a new composition that will increase shelf life of the munitions inside. By reducing the size and extending the shelf life, maintenance, storage, and transportation costs will be lowered. Advanced containers have also seen breakthroughs in providing rounds better thermal protection, which avoids ammo performance degradation and enhanced lethality. This too reduces the life cycle cost for the munitions over its life expectancy.

The Army's Insensitive Munitions Integration Program (IM) is the latest munitions survivability program in response to DOD Regulation 5000.2R. In this reference, insensitive munitions are "those that are resistant to unplanned threats such as bullets, fragments, shaped charge jets, and relations to neighboring munitions."²⁷ Congressional oversight has become

increasingly prevalent in the last few years to ensure future munitions consider preventing sympathetic detonation of ammunition stores as a result of an unplanned event. Because of sympathetic detonation, fragments and fire, one hostile act (or accident) can initiate an explosive event or fire that can quickly destroy an entire Ammunition Support Activity (ASA) numerous stockpiles of munitions, or the weapon, or transport medium. Such was the case during DESERT STORM, where for example, "a heater fire in an artillery resupply vehicle led to an accident which nearly decimated an entire Army battalion (over 150 vehicles lost) and resulted in a \$40 million loss."²⁸ Congress, with the Joint Requirements Oversight Council (JROC) as the enforcer, has said it will delay or prevent future munitions fieldings "unless the services develop, demonstrate, and implement technologies that reduce the vulnerability to unplanned stimuli."²⁹ The Army's approach to this problem has been to first assess the IM status of all munitions. Next, the Army plans to assess availability IM technology by leveraging existing technology from other services, foreign and commercial sources. Based on these assessments, the plan is to determine an IM priority list then improve performance by the development and stockpile of munitions.

The technologies the Army will work with include using advanced explosive mitigation materIELS, employing high

performance fire blocking materiels (blankets) and developing sympathetic detonation criteria for Army munitions. In doing so, the Army will attempt to develop Firebrand and Fragment Propagation models that use predictive algorithms to improve survivability of deployed munition supplies from projected threats. This initiative is currently outlined in the TRADOC Future Operational Capability TR97-033 for munitions survivability.

21ST CENTURY MUNITIONS RESUPPLY SYSTEM

Focused logistics support for the Army of the 21st Century will require anticipatory, distribution based munitions resupply. "Our new ammo doctrine is hanging its hat on the new concept, the Strategic Configured Load (SCL)." ³⁰

The problem has been that the current resupply system has been predominantly breakbulk shipment from depot to theater where theater and corps storage areas perform a very slow, manpower intensive process to offload/transload bulk munitions in single Department of Defense Identification Code (DODIC) configuration pallet by pallet. This process has been estimated to be between 1.5 to 3 times more manpower intensive and very costly in terms of time and materiels involved in the system.

The objective then is "to provide robotics, sensors, and modular ammo packaging and distribution technologies to help

modular ammo units rapidly build warfighter tailored munition packages for resupply.”³¹ SCLs have been termed a Force XXI and AAN “Log enablers” and have become one of the logistics community’s “hot rocks” to becoming proactive to serving the needs of DOD and the warfighter. The mission to build and issue configured loads has been identified in both current and future doctrine, and is considered crucial in fully realizing the Revolution in Military Logistics (RML). As LTG Coburn, the DA DCSLOG put it, “SCLs will provide a Revolution in Military Logistics for ammunition.”³² Configured load building capability, not only meets the Army’s Vision for the logistics future, but also meets the Joint Vision 2010 for focused logistics:

to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations. It will be fully adaptive to the needs of our increasingly dispersed and mobile forces, providing support in hours of days versus weeks. Modular and specifically tailored combat service support packages will evolve in response to wide-ranging contingency requests.³³

A strategic configured load is “ammunition configured at a strategic CONUS location in a complete round mix for a unit or weapon system which would require little or no reconfiguration in theater to meet specific AOR requirements.”³⁴ The concept of SCLs has been discussed for about five years; primarily in the CASCOM/TRADOC community as the potential operational concept for

the ammunition distribution system. The concept hinges on the notion that ammo resupply can be modular and designed to meet Army unit-specific ammunition needs. These pre-designed and configured loads will be assembled at the depots, thereby streamlining the depot-to-theater movement of ammunition assets. Why SCLs? Use of SCLs will reduce the logistics in-theater footprint by providing battlefield agility and transportation velocity. A key to the RML tenant of an adequate logistics footprint is to trade mass for velocity and agility in support - SCLs can do just that.

The SCL concept further incorporates the use of Container Roll-in Roll-out Platforms called "CROPS".

This handling device is designed to permit uploading/unloading unitized loads to and from an International Standardization Organization (ISO) container to a Palletized Load System (PLS) truck. The PLS capability expedites downloading of ammunition assets in theater and subsequent redistribution to units in the field as required.³⁵

This depot to foxhole capability has many benefits. First, it optimizes the advantages of containerization. Supply transload by containerization is quicker than breakbulk by a factor of three. For example, using containerized ammunition shipments, Korea was recently able to demonstrate reduced offload time from three weeks to one for similar amounts and type of ammunition during TURBO CADS '98 - a joint transportation containerized ammunition exercise conducted in

April 1998. At \$30,000 per day transportation costs, the cost avoidance in one event was \$420,000.

Other advantages in using configured loads include increased flexibility for in-theater mobility of Class V - key to sustaining an agile/mobile offensive capability on a high OPTEMPO battlefield.

SCLs will reduce handling of ammunition in-theater which has become critical because the number of Ordnance Companies (Ammo) have been reduced with the force structure drawdown, fewer personnel available to setup and maintain Theater/Corps ASPS, and higher consumption rates for modern weapon platforms.³⁶

SCLs can be designed for specific unit needs. For example, engineer, armor, aviation, infantry, and artillery packages can be tailored. Additionally, minimum changes to load configuration are needed in-theater for mission specific needs. Therefore, SCLs save time and manpower for the ultimate consumer - the soldier.

Strategic configured loads are a doable thing and should be done. However, there are still many impacts and issues which the Army must address. Going to this concept of support will take a drastic increase in the total container outload requirements. Over 80% of total CSS tonnage is ammunition in a Major Theater War (MTW) requirement for sustainment. Yet, up until recently, most of what was planned for container outload was not Class V. This support concept will additionally

generate even greater requirements in materiel and container handling equipment (MHE/CHE) to stuff, transload, and unstuff containers. There is already a known shortage of HME/CHE in our infrastructure that the Army must resolve for the future.

Some major impacts of going with the SCL concept also will effect some major changes in the depot infrastructure. A couple of personnel issues to include a major increase in depot personnel to require training for outload and an enormous workload during support for contingencies. Infrastructure upgrades at depots to accommodate containers and CROPS will require resourcing to make SCLs a reality. In deed, this new concept will require a total re-think of ammo asset distribution at Tier 1 level depots.³⁷ This comes at a time when depots are facing the same cutbacks and personnel reductions as the "green suiters".

Other impacts affected at this point include the second order effects this concept would have on strategic lift planning for US Transportation Command (USTRANSCOM). The concept also must look at IOCs role to support all services during contingencies because the Army has executive agency for Class V support. Once SCLs are decided, what if any flexibility is there to change loads? Each of these impacts must be successfully addressed to realize the potential SCLs can provide the warfighter as well as the logistician.

As much as the SCL concept has to offer, there are yet some significant hurdles to overcome. Funding is a major concern. "IOC would love to do SCLs. IOC can do SCLs -- if someone would pay for it and not decrement ammo's budget as bill payers."³⁸ Redistribution of ammo assets to make viable quantities available would be required as part of a "war reserve" base within CONUS. However, tiering of depot assets does not currently recognize SCLs, consequently few combinations are located at a single depot.

Even if all the ammo was distributed to maximize the SCL concept, many ammunition combinations fail to meet storage and shipping compatibility requirements for safety. The US Army Technical Center for Engineering Services (USATCES) has supported the SCL concept by reviewing the latest 49 proposed configurations. Twenty-nine SCLs were found to be compatible at all times for shipment and storage. Twenty do not meet peacetime transportation standards. Currently,

the Department of Transportation (DOT) exemption 3498 allows for the shipment of normally incompatible items during periods of declared national emergency or during contingencies requiring expedited movement of US Forces. This exemption applies to highway, rail, and sea movements, not air shipments.³⁹

Of these twenty configurations, all but five were compatible, if depots utilize special compatibility storage criteria. The remaining five sets were never compatible due to

the presence of white phosphorous (WP) munitions. There is already a more detailed SCL Compatibility Tech Analysis being conducted at present, based on current compatibility criteria and possible testing to determine if current charts are valid or more SCLs can be acceptable without waiver. This will be initiated as soon as the SCL concept receives official DA approval. The hope is that waivers for all SCLs will be prepared and approved ahead of time so that if the need arises to support a crisis action, there will be less delay to initiate outload.

Given that waivers can receive approval, another second and third order effect will be to develop new drawings and specifications, suspension, and restrictions for transport of SCLs in CROP containers. DA DCSLOG has the lead to prepare and publish the documentation required for ammunition in the current inventory as well as modern ammunition under development before its fielded.

In the future, the Army will be supported by an Ammo Distribution System that employs modular ammunition units in theaters of operation and uses the workforce at CONUS depots to provide sustainment ammunition as Strategic Configured Loads (SCLs). This ammunition will be loaded on CROPS and shipped in containers from the depot to the corps ammunition storage area. Logisticians have estimated that

as much as 95% of the ammo coming into a MTW in CROPS already configured to unit requirements will be realized. This would allow some bypassing of the Theater Storage Area (TSA) and onward movement through transportation hubs directly to the Ammo Transfer Points (ATPs) in some instances.⁴⁰

What's doable in the near term? SCLs could be tailored to support smaller regional contingencies and exercises with potential of escalation beyond initial on hand supplies. Tailored loads for specific units should be the norm. Those actions which are of a small enough magnitude that will not warrant the partial download of a pre-positional ship would greatly benefit from SCLs. This resupply method strongly supports the mobility characteristics of today's military peacekeeping actions (Bosnia - Kosovo). Additionally, the concept of limited application of SCLs should be briefed to the other services due to the joint nature of most US military actions today. In the recent past, US military actions have been relatively small and highly mobile. Size and mobility should be the two test criteria for the use of SCLs in the future.

So it is apparent that although the SCLs concept represents a tremendous ability to streamline the ammo logistics system and reduce handling in a theater of operations (smaller footprint) the infrastructure, namely the industrial base must bear the weight of the transition. At a time when reductions are the

norm, how can we optimize the production base to be more efficient and take on the workload required to support SCLs? Our next section addresses this issue.

AMMUNITION INDUSTRIAL BASE

Late summer of 1998, GEN Reimer, CSA directed the CDR, AMC to look at the ammunition industrial base. LTG Coburn was sent an email on 19 Sep 98, by GEN Wilson saying "I'd like to put together a task force to look at the ammunition industrial base...a task force of experts...headed up by a military officer...one or two gray-beards...one or two industry experts."⁴¹ Major changes in our National Military Strategy, coupled with pressures to reduce the federal budget, have led senior officials in the Department of Defense (DOD) to reassess how the ammo industrial base is managed. Innovative ways to meet the needs of the warfighter are needed.

Dramatic changes in the threat environment has significantly reduced the government's needs for munitions. Government managers and industry executives have been in a continuous struggle over the last seven to eight years to deal with the precipitous drop in funds available to procure and maintain critical production capabilities. The result is a munitions industrial base in a near-crisis condition no longer able to surge to meet a major contingency. In fact,

skills, knowledge, and specialized production assets are being lost as commercial producers exit the munitions production business in large numbers and government organizations go through major downsizing exercises.⁴²

Commercial industry is very skeptical about staying in business with government due to unstable procurement strategies by DOD. The government-owned portion of the industrial base is very inefficient because production processes are oversized for today's requirements and use of old technology. Current fiscal realities preclude significant government investment in modernizing and right-sizing the production base.

The problems in the munitions base have been evident for some time. A number of government agencies and industry groups have studied various aspects of these issues repeatedly.

The Hardin Study, part of the Packard Study in 1980s, the FY 1990 Ammunition Production Base Report to Congress, and the OSD Ammo Industrial Capabilities Report to Congress in 1996 each talked about drastic changes needed in management structure, production and workload capacity, and industry's inability to meet surge requirements.⁴³

In order to get a fresh perspective on the problem, the Army's Deputy Chief of Staff for Ammunition tasked Pacific Northwest National Laboratory (PNNL) to perform an arms length comprehensive independent assessment that would serve as a catalyst for changing the way the government carries out its munitions business. The key objectives of the project were

to perform an independent assessment of the capability and capacity of the munitions industrial base and to recommend an integrated strategy for configuring and managing the base to effectively meet the needs defined by the defense Planning Guidance (DPG).⁴⁴

This assessment was directed at the production base for conventional ammunition and included missile components which are made in the industrial base as well as assembly operations in the base.

THE PNNL STUDY

The PNNL Study deserves some attention in this paper due to the dramatic recommendations it produced. The Army directed PNNL to take a clean sheet of paper perspective in the assessment. Everything in the production base or outside influences were all fair game in the assessment. PNNL was encouraged to "recommend strategies using outside-the-box thinking that required enabling legislation, policy changes, or major shifts in organizational responsibilities - if such changes could make major improvements in the performance of the base."⁴⁵ The approach and key activities PNNL used in the Munitions Industrial Base Assessment are seen below in Figure 7.

Key Activities in the Munitions Industrial Base Assessment

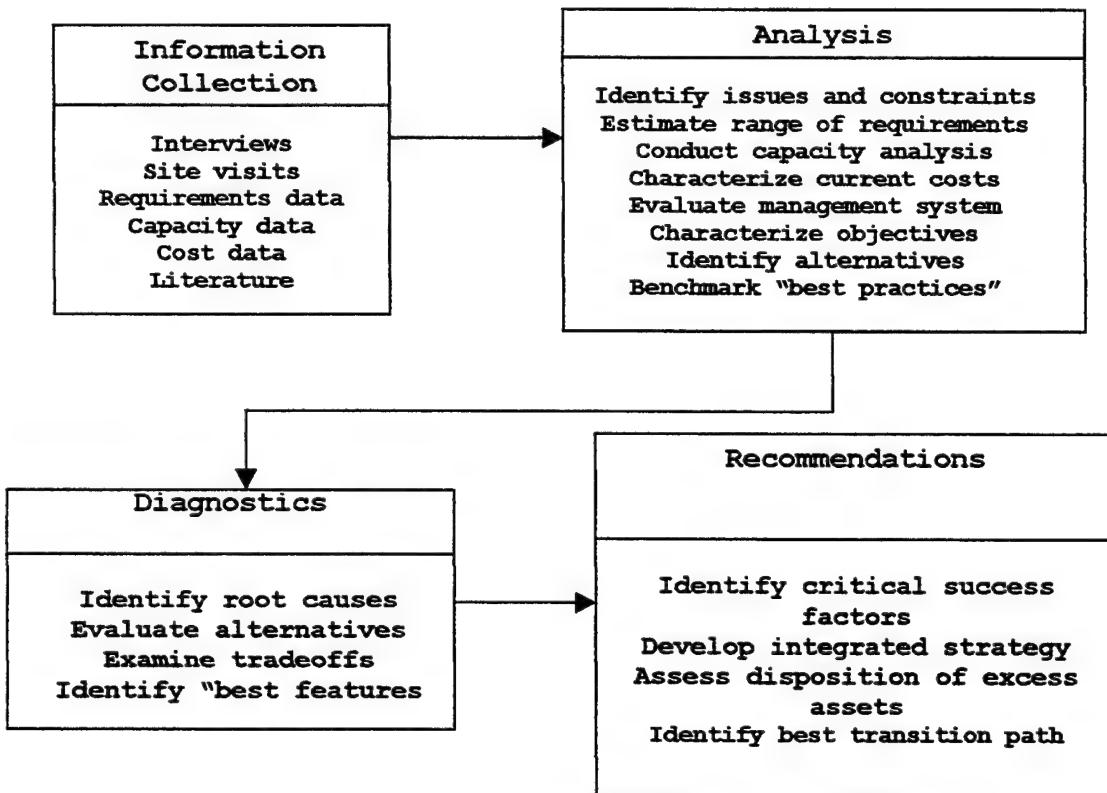


Figure 7, PNNL Study, 6-97

Throughout the assessment, PNNL focused on interacting with key stockholders to make sure they understood their perspective. They met with senior managers at all main commercial suppliers of ammo, the Munitions Industrial Base Task Force (MIBTF), the Industrial Committee of Ammo Producers (ICAP), and the American Defense Preparedness Association (ADPA). They interviewed managers from the Industrial Operations Command (IOC), the

Armament Research, Development, and Engineering Center (ARDEC), the Deputy Chief of Staff for Ammo (DCS Ammo) AMC, and the Office of Munitions in the Office of the Secretary of Defense (OSD). They visited each of the active Army Ammunition Plants (AAP) and a representative set of inactive plants to survey production facilities and obtain capacity information to determine surge capability. "The major performance measures for the base turned out to be cost, responsiveness, and reliability. Tradeoffs among those performance measures were examined looking for alternatives that would achieve a reasonable balance from a taxpayer's perspective."⁴⁶

Key findings of the PNNL Study were focused around three major themes; the capability and capacity of the production base, the management system, and the business environment.

A fundamental conclusion of the study is that there is really something special about ammunition and ammunition production. It requires knowledge, skills, and a "mind set" that are distinct. The ammo community who develops and produces munitions, and manages the business process, is an identifiable community.⁴⁷

The PNNL Study agreed that the idea to transfer ammo managers to weapons system managers like a family of vehicles would have a negative impact on our ability to develop and produce munitions. This would not be a focused approach. A family of weapon system munitions would be too fragmented and have a tendency not to be strategic in viewpoint, but more

service oriented. This conclusion became a fundamental principle on which the study built its recommendations.

For the production base, better integration and coordination in the resource allocation process could have a major benefit. The current process is imprecise using warfighting models with limited data and constant changes to the MRC parameters. The result is new and different data because there is no common ground on assumptions, data, and parameters utilized. Additionally, there is a downward trend in replenishment requirements due to budget constraints, doctrinal changes, and smarter, more lethal munitions. Technology will continue to see improved accuracy and lethality to further decrease the requirements. Hence, fewer munitions are required to achieve the desired military effect. However, the shift towards smart rounds is budget-constrained. Although fewer rounds are needed, the rounds are much more expensive. Conventional rounds are being retained in the inventory to compensate for the shortfall of smart rounds.

A major focus of the assessment was to determine whether the current production base (both organic and commercial) has the capabilities and capacity to meet the peacetime and replenishment requirements. "In most cases, the base does have the capacity and capabilities to meet peacetime and replenishment requirements, but not efficiently or in a timely

manner."⁴⁸ Figure 8 illustrates the fraction of end items for which the total replenishment requirement can be met as a function of time.

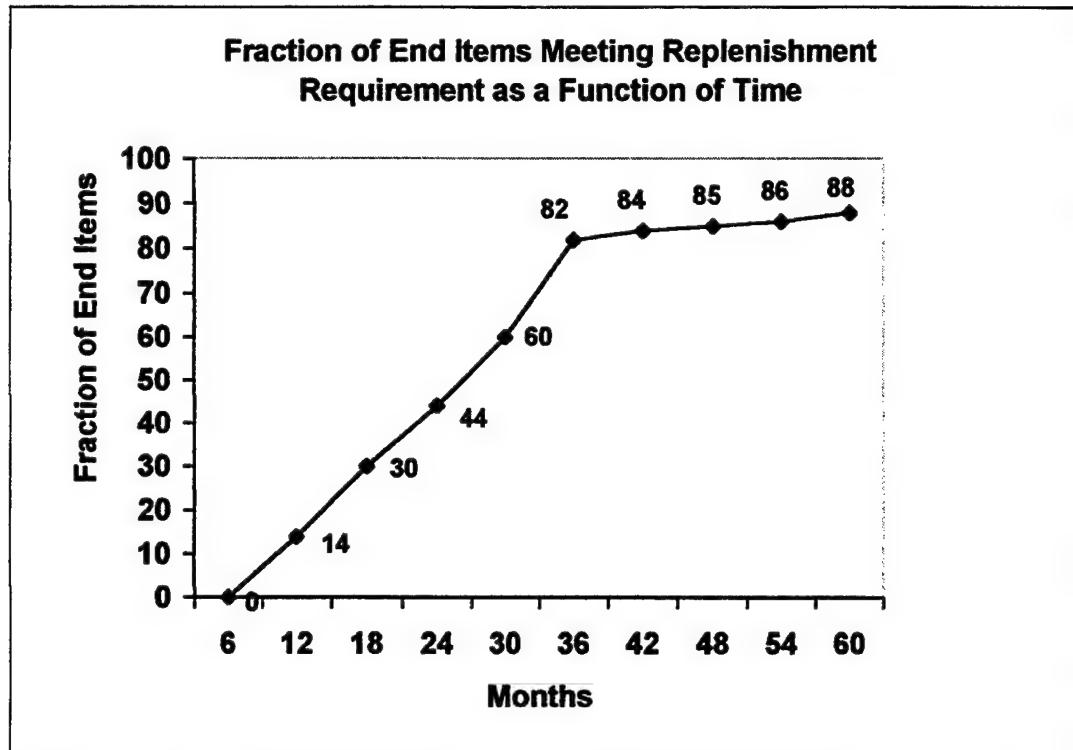


Figure 8, PNNL Study, 6-97

What the data indicates is that:

At 30 months, the complete replenishment requirement could be met for 60% of all end items. It would take nearly 60 months (5 years) to achieve nearly 90% of required items. Hence the production base can meet current replenishment requirements primarily because both the requirements and peacetime buys have been drastically reduced over the last several years.⁴⁹

However, this spiral effect has had a negative effect on the number of producers for long lead time components for bomb

bodies, shell bodies, and other specialized metal parts. Reductions have led to a hand full specialty producers of metal parts, thermal batteries, and integrated circuits for fuses. It will take far too long for the base to surge to meet replenish/sustainment for a MTW scenario. Another finding was that:

Most replenishment capacity in the organic base is very expensive, particularly in propellant and explosives. Most plants were assessed at operating at only 5-10% of capacity for peacetime, and would run only 40-70% capacity during replenishment. A companion study performed by Science Applications International Corporation (SAIC) estimated the cost penalty of underutilized capacity across the organic base to be in the range of \$150-200 million per year.⁵⁰

The cost of underutilized capacity is being loaded on current production, distorting prices, causing customers to seek other sources of supply.

Next, the PNNL Study found there are unique assets and processes in the production base. "The most important asset at the government-owned sites is the real estate and permits needed to conduct operations that are driven by quantity/distance considerations."⁵¹ There are ammo-unique production processes that include depleted uranium machining, long-stroke forging, propellant and explosive loading, and sabot composite manufacturing to name a few. It is the tech base that clearly sets the US aside in terms of accuracy, lethality, and reliability. However, the study notes that our tech base has

developed and maintained its edge through a continuous interchange between developers and producers. Production buys sustain the tech base by keeping the skills in use. Government funding of R&D along with industry internal R&D move the tech base forward. The PNNL Study said:

The down turn in ammo budget has put the tech base in jeopardy. Producers are bailing out of the business taking the valuable know-how with them. Unstable business conditions are causing industry to cut back on its IR&D, thus has led to a "graying" of the ammo community in both government and industry as our most critical knowledge and skills are approaching retirement age.⁵²

Over all, the management system is fragmented. There is no central decision-making authority to focus key business processes such as budgeting, war reserve management, life-cycle management, and R&D planning and integration. A stable business environment is critical to the future viability of the commercial part of the production base. Some of the realignment that has taken place is a natural result of the DOD re-sizing of its munition needs. However, ammunition lacks a strong cohesive voice in the budget and requirements process. There are "too many cooks" in the process ranging from OSD to Congress, to PMs, and MSCs.

The munitions business environment is not healthy. Industry will invest when risk and return on investment are reasonable - otherwise they will not waste investment dollars. Only a few

ammo business segments are reasonably healthy, like tank ammo and tactical missiles where multiyear buys are the norm. In these cases, industry will invest technology dollars in the development and production of high-tech production equipment. Gaps in funding buys for end items and components (like ammunition) force producers to either eat idle capacity or go out of business. There must be a better approach to procuring munitions without a breakout contract mentality. The central planning and workload approach to production base management is not agile enough to deal with current levels of uncertainty causing less efficient performance, constrained technology efforts, and the general feeling that GOCOs could be done more efficiently by private sector.

The PNNL Study concluded that the government must conduct its munitions business in a new way. Incremental improvements to the current system will not achieve the desired results. The study recommended a four-part strategy to achieve the ultimate goal of an efficient and responsive munitions development and production system. This includes:

Manage the production base as a major program, using the DOD life-cycle acquisition process and minimizing government control. Consolidate munitions management responsibility and financial resources for munitions by establishing a Program Executive Office (PEO) for Ammunition. Commercialize the organic production base. Convert government-owned production assets to commercial activities while preserving the ability to conduct operations with major Quality/Assurance (Q/A)

requirements to maximize asset value. Reforge acquisition initiatives to help stabilize the business environment and incentivize industry investments in the production base. Make larger, long term buys that bundle peacetime buys with replenishment services.⁵³

In looking at this PNNL Study, the most comprehensive review since 1989, the aim was to focus government activities on accurately expressing the total needs for munitions. The big change is to let industry, operating in a competitive marketplace, determine how to best meet the needs. In this way, the Army will rely on private sector to create and sustain production assets. In mid December 1998, AMC briefed and received approval from the Assistance Secretary of the Army for Research Development and Acquisition (ASARDA) to implement a new Industrial Base Policy 98-1. This policy reiterates three of four PNNL recommendations to include where feasible, transitioning organic assets to the private sector. The policy takes an aggressive, yet synchronized course of action to include using the new policy now in its future ammunition procurements, where possible in the near term 3-5 years. It outlines measurable objectives for full and open competition allowing the contractor (commercial industry) to solve the problem. It offers incentives for peacetime buys plus replenishment capability with no site/facility limitation. The aim, "to seek efficiencies, utilize innovative acquisition

strategies, reduce cost/footprint and increase our return on investment."⁵⁴

Bottom line, Policy 98-1 has dramatically helped to reshape the munitions industrial base. Considerable progress has already been made in this past year:

major improvements in government business practices, excess plant capacity being divested, a commitment by IOC to have no "work loading" production contracts by FY 2007, use of more multiyear and multiple year contracts, and better partnering with industry for innovative solutions.⁵⁵

Some recent examples of success to illustrate what AMC has done include competition of a 5 year, fixed price solicitation for Lake City Ammo Plant. By doing this they were able to identify excess plant capacity to a civilian contractor who was willing to invest \$10 million of his on IR&D dollars. By doing this, they were able to realize a 20% price reduction over the next 5 years at 1/8 the original production cost estimated. Similarly, overhead absorption of 28% at Radford and 18% at Iowas AP means lower prices for AP propellant and tank ammo respectively.

The Army 's response in accepting the PNNL's recommendations in principle has meant a spring board for change in how the industrial base for ammunition will be managed in the future. The Policy 98-1 was written and approved by the Chief of Staff of the Army who is now comfortable with the new management of

the industrial base and the vision to move it to the future. "That vision is to respond to national needs, minimize resources, to sustain the base, and create economic partnerships with industry that benefit all parties."⁵⁶ From this vision a new initiative called the Armament Retooling and Manufacturing Support (ARMS) has been started. The goals are to support our peacetime and replenishment requirements while producing ammunition at the lowest cost. To do this, the ammunition community will have to reduce facility/equipment cost by divesting with commercial industry who, under the right incentives will want to invest capital in infrastructure and high tech production modernizing programs. This is a win-win situation for a Government-Private Task force to maximize facility value and output while retaining and growing a skilled labor source to keep our high tech edge. Through commercializing the ammunition industrial base, leaders hope to optimize social/economic benefits.

The challenges in this massive effort will require a culture change which has been slow coming. Remember studies dating back to the mid-1980s also called for some of the same changes in the industrial base. Implementation required has included changes in key government personnel, education of new senior decision-makers, getting industry to "buy in" and a "TRIAD" of GC IOC, TACOM, and PEO GCSS "to pursue a joint goal of pursing the most

comprehensive and cost-effective approach to the life-cycle management of munitions for the Army.”⁵⁷ This new Ammo Executive Council or TRIAD knows that the changes required in the PNNL recommendation will require an incremental process over the next 10-15 years. However, planning and execution appear to be moving quickly. The TRIAD has already hosted a Munitions Summit with all the key stakeholders present. Congressional interest has been high. So the TRIAD has been working hard to ensure those representatives with plants in their districts are kept abreast of policy changes and management decisions, which may affect their constituents.

The strategic approach for the future of the ammo industrial base will be along two major thrusts. First, a look at ammo plants (active and inactive), based on the PNNL Study to see which plants can best take on the new acquisition reform approach for greater industry involvement. In doing so, the Army wants to compete the problem not the solution, letting industry show us smarter ways to divest and use their investment capital to improve production facilities. This has already been done with FY98 contracts at Holston AAP where they are the sole source or primary producer of all explosives used by the military using RDX or HMX. “The peacetime utilization rate of this AAP was estimated at 20-25% capacity and a cost of underutilized production for replacement of \$26.4 million per

year."⁵⁸ In this case, a \$10 million commercial investment by North America Ordnance will reduce cost by 20% at a savings of \$180 million over the next 5 years.

A second approach under the ammo plant is to implement what they call a "Phased Site Manager" concept. This concept transitions government-owned sites to the commercial site manager who operates in a tenant operating mode. Commercial management comes into the facility, identifies ways to maximize plant capacity between government production and commercial application. By commercializing the plant, the facility achieves a better profit stabilization threshold that will one day have minimized the risk of operation to the point the commercial partner wants to privatize the plant and have the government sell the plant outright. This may be the case in late FY99 for Scranton AAP and at Mississippi and Riverbank AAP where out year ownership may in fact transfer to the private sector.

The other avenue of approach recommended to the PNNL is to tailor acquisition strategies by munition families. This is being looked at in family based munitions such as tank ammo, artillery, medium and small caliber rounds, mines/countermines, mortars, and fuses. In order to proceed on this line of approach, the Army would require a very disciplined approach that must have the entire munitions family as integrated team

considering the entire life cycle of the munitions. It will require a family life cycle strategy that includes approval of a business plan, an acquisition strategy, and for an industrial plan. In doing so, a project manager for an entire family of munitions would take the load. IOC would identify requirements for peacetime/replenishment. The life cycle business strategy would look at ways to optimize multiyear consolidated buys with replenishment options for that family of munitions in a way that maximizes component integration, industry partnership, and competition to get the best bullet for the buck. At present the Ammo Family Teams are conducting their Integration In Process Reviews (IPRs) which are projected to complete their studies and recommendations by late FY99 to the Ammo Executive Council.

Overall, the industrial base has completely revised its strategy for the future. The reshaping of the industrial base means managing ammunition using DODs life cycle acquisition process. It means using acquisition reform initiatives to stabilize the business environment and provide incentives for private investment in the production base using Family-Based Acquisition Strategies and smarter business plans with the private sector. It will mean a greater reliance on the private sector to create and sustain ammo production assets in response to production and replenishment contracts. To the maximum extent feasible, it means transitioning government-owned

ammunition facilities/assets to the private sector while preserving the ability to conduct explosive handling operations safely. To support the warfighter in the future, the industrial base has to maintain a warm base capable of flexible manufacturing to respond to peacetime as well as wartime requirements. The reshaping must take place now.

OPERATIONAL CONCEPT FOR THE AAN AMMUNITION SUPPORT

"A soldier can survive on the battlefield for months without mail, weeks without food, days without water, minutes without air, but not one second without ammo!"⁵⁹ Clearly, munitions are the dominant factor in determining the outcome of combat or stability and support operations. You can not execute the operational tenants of fire and maneuver without munitions. In fact, our force projection vision and concepts for the AAN are critically dependent on ammunition. The limited quantity of our modern munition and new weapons systems in the future predicate or dictate munitions will be managed closely to ensure its availability and enhancement of combat readiness. Therefore, the doctrine for ammunition support must change in order to support requirements and capabilities for a future Army After Next.

As we look to a future operational concept for ammunition support, it is necessary to look at a broad summary of the

changes in the domains of doctrine, leader development, organization, materiel, and soldier support (DTLOMS). The operational concept for ammunition support for the 21st Century encompasses the entire ammunition distribution system and its elements. These elements include:

munitions movement (to/from CONUS), munitions survivability, ammunition management (via some Standard Army Information Systems (STAMIS)), ammunition logistics materiel systems, and ammunition storage and operations both in CONUS and in theater.⁶⁰

So what's driving the need to change our concept? The requirement clearly has come out of an "operational necessity to support warfighting concept to include force projection, peace operations, humanitarian assistance, and operations in aid of civil authorities."⁶¹ The ammunition support force structure must be strategically capable of providing agile support to respond to a broad spectrum of worldwide requirements. We know that as our battlefield technology increases, the importance of an efficient and highly responsive ammunition support system will grow proportionately. Additionally, as the need for ammunition lethality increases, the costs are expected to increase. At times when the DOD budget is shrinking, and as seen earlier in this paper, the costs of maintaining munitions increases; the outcome will undoubtedly be procurement of fewer preferred or critical munitions. What is certain to result then will be a trend to increased Controlled Supply Rates (CSRs) for

critical (preferred) munitions. This is currently not the practice, meaning some key decisions will be required for central release authority for certain specified missions only. In a sustained battlefield environment, there will then be more challenges for warfighter's to know when to make the call for authorized substitute munitions. The future logistics systems for ammunition will have to have the requisite flexibility to provide mission-specific munition packages to meet the needs of the combat commander. "Tactical success will be achieved by ensuring the commander has the munitions on time, and in the correct combat configuration to meet his objectives in dominating the battlefield."⁶²

DOCTRINE

The old Army of Excellence (AOE) CSS concept for arming the force was stockage based loads. The new concept calls for more flexible level of support using Strategic Configured Loads (SCLs) and a battlefield distribution system that improves movement of these configured loads by use of modular ammunition support units in the force structure. Current ammunition doctrine states "the philosophy for ammo support for Force XXI and AAN does not change, and lends itself well to supporting a force projection Army."⁶³ It will still come down to ammunitions units being able to provide the right munitions, at the right

time, and right place using a distribution system with the same tenants of future Army operations. These doctrinal tenants are applicable across the entire operational continuum of conflict.

Future doctrine must continue to underscore the joint and multinational nature of future operations. The ability to synchronize all available ammunition assets while avoiding duplication of other services or allies must still be established in our doctrine. In order to transition to a joint and multinational ammo operations, we will require different integration processes than those used during the Cold War era. Doctrine in the future will require a more honest multinational and joint effort to streamline and force the issue of interoperability. This must span the spectrum from procurement/acquisition of similar weapons technology to sustainment assets. It should be noted that "although we say standardization and interoperability are the ideal, political issues and service parochialism have limited our efforts to continuing progress only wherever feasible and practical."⁶⁴

TRAINING

"One of the toughest challenges for ammunition units is the training shortfall of commonly excluding it from training exercises and programs."⁶⁵ There are several reasons that this shortfall commonly occurs. First, is that few maneuver level

units understand ammunition units, their support doctrine and sustainment imperatives. Because of this, ammunition units get left out of great training opportunities with the exception of NTC or CTC rotations. It takes some coordination, but adding Class V support into the field training exercise environment is the only way to prepare for war. Many times staff exercises at division or echelon above division/corps (EAD/EAC) experience so few personnel with Class V expertise at the Materiel Management Center (MMC) level, ammunition units get tapped to provide senior personnel (non-commissioned officers, warrant officers, field grade officers) to augment their munitions staff or man the "white cell" to facilitate notional ammunition data to the staff. This was the case the last several years in Korea. With shortages of transportation funds to augment staffs with Reservists from CONUS, several key exercises to include Ulchi Focus Lens, RSO&I (Receiving Staging Onward Movement and Integration, and Foal Eagle, each decremented the theater's only ammunition battalion 7-10 senior personnel prohibiting the battalion from increasing its training value by participating as they would in war.

Compounding training shortfalls is the problem that our peacetime ammunition distribution system is dramatically different from the wartime vision. Ammunition organizations must be included in active duty, reserve, and joint operational

exercises. Ammunition units' preparedness and interoperability must be tested and reinforced in joint warfighting exercises. Every training event must be planned, synchronized, aggressively executed, and thoroughly assessed. That training must be tough, realistic, and focused on capabilities and requirements across the entire operational continuum. In war, ammunition support will have to be relentless to sustain our modern weapons systems on a high OPTEMPO battlefield. Nothing short of war could replicate the intensity for which Class V sustainment will require, but commanders must teach their leaders and soldiers the complexities of trying to sustain and at the same time remaining survivable on the battlefield. From working with innovative technologies in software to more progressive ammunition survivability, ammunition units must ensure they train as they will fight and sustain in war.

Institutional training can take place using TRADOC Pamphlet 525-5, Force XXI Operations, and Field Manual 100-5, Operations. Although use of training devices, simulations, and simulators can help, ammunition personnel must be provided field training experience to ensure their survivability on the battlefield. LTG (Retired) Gus Pagonis had a motto on the hallway in his Division Support Command (DISCOM) Headquarters at Fort Carson, CO. It read, "Soldiers First, Technicians Second to None". That is exactly the essence - "soldiers need to be oriented

toward battlefield operational policies and tactics, techniques and procedures, as well as become familiar with field equipment, facilities, organization, and logistics."⁶⁶ These logisticians must be the absolute subject matter experts in ammunition sustainment. They must be able to plan and execute synchronization of ammunition support with other CSS activities on the battlefield. There should also be a higher level of participation from customer units to ensure they know how to coordinate basic load pick-up and sustainment support. Too few leaders really understand ammunition and often assume its sustainment away. Class V is the lifeblood of combat operations - those that learn and appreciate that will train with ammunition in the future.

LEADER DEVELOPMENT

Ammunition leaders must fully understand the doctrinal tenants of the new support concepts under AMMO XXI and the AAN. "Modularity requires that these leaders be fully capable of leading their organization(s) as a coordinating and sustaining headquarters; proficient in commanding and working as a part of multifunctional organizations on the battlefield."⁶⁷ These leaders must also be developed in a support environment that stresses tailorability as well as multinational, joint, and host nation support operations. Tomorrow's ammunition leaders must

be proficient in commanding ammunition units that can be rapidly and quickly projected throughout the globe. Senior ammunition leaders also must be multifunctional logistics proficient because future logisticians can not be technically proficient in just one discipline. They have to be part of an Army that responds not only to our service requirements, but joint and international in its focused logistics. Future leadership courses must provide our officers and non-commissioned officers this complete spectrum of training and support background.

"Efficient and effective ammunition distribution to support our Army After Next will require skilled and competent soldiers and leaders who will continue to remain the Army's most valuable assets."⁶⁸ The key will continue to be teaching and mentoring our ammunitions of tomorrow, how to anticipate the time sensitive and asset limited requirements that will drive a force projection Army. This is a vital concept of battlefield success for the 21st Century.

ORGANIZATIONS

Ammunition units and their structure will definitely change to meet the needs of tailored support for a force projection Army. "Ammunition units must be as small as possible, yet retain functionality."⁶⁹ In keeping with the Revolution in Military Logistics tenant of "adequate logistics footprint" our

future ammunition units will follow the principles of modularity, which allows leaders and logistics planners the ability to quickly tailor critical ammunition support where and when required to sustain force projection operations. By retaining a modular base, the ammunition units can easily expand if the demand rises. Organizational designers like those at CASCOM, will have to integrate emerging technologies and consolidate ammunition functions, specialties, and materiel.

One of the very important doctrinal changes on the horizon for munitions support incorporates the maneuver-oriented ammunition distribution system, palletized load system called "MOADS-PLS". This allows for extensive use of PLS for the distribution of ammunition. The second doctrinal change is the modular ammunition platoon concept. In this concept, there are two types of modular platoons, heavy and medium lift. The heavy lift platoon (HLP) is best suited for port, theater storage area (TSA) and corps storage area (CSA) operations. Medium lift platoons (MLPs) operate in the TSA and CSAs when required. These platoons are capable of deploying and operating in an autonomous/semi-autonomous mode away from their company headquarters, although requiring external support for their sustainment. These platoons operate ammunition supply areas in corps and division areas. It is this concept which allows the Army to leverage the advantages of technology and the PLS,

incorporating strategic and mission configured loads (SCLs/MCLs). Under this configuration, palletized loads can be throughput direct to TSAs, CSAs, and ASPs. "The actual number and size of platoons deployed into a theater or corps area is determined based on the commanders intent and on mission, enemy, troops, terrain, weather, and time available (METT-T)." ⁷⁰ It will be these units and their modular capability that will be pivotal in providing the commanders on the battlefield the flexibility to tailor his sustainment when and where needed to meet his operational requirements. It is this seamless support structure that remains adaptive and flexible to match the ammunition workload requirements to both actual unit resources in a precise and efficient manner.

MATERIEL

Under the tenants of Army operations doctrine presented in FM 100-5, there are several key principles that have established the framework for our future materiel requirements for ammunition sustainment. These are agility, depth, and versatility. The combat and materiel developers of the ammunition logistics community must continue to exploit these principles by looking for opportunities in technological design to acquire and field more capable systems to support the AAN

force. As stated earlier in this paper, critical enabling technologies for survivability will:

include rapid composite barricades, fire blocking blankets, hazardous electromagnetic radiation to ordnance (HERO) detection, lightening protection, and smart automated information technology (AIT) software for optimizing construction of survivable and more efficient ammunition storage access.⁷¹

The CROP as well as enhanced materiel and container handling equipment (MHE/CHE) will help optimize ammunition packaging in an attempt to trade speed of distribution for mass. These velocity management enablers will see technological advancements like robotics or remote-operation MHE, container improvements and imbedded smart sensors to monitor ammunition in storage and transportation. Overall, our concept developers do not think a dramatic change will occur in our container/materiel handling equipment. However, there will be better ones to replace an aging fleet with quicker more agile handling capabilities. A 50,000-lb. forklift is scheduled to eventually replace all the Rough Terrain Container Cranes (RTCCs).

Improvements in ammunition packaging will not only enhance production for munitions, but will provide greater ease of access for throughput. Currently, there are several initiatives in cooperation with the civilian ammunition industry "to develop, evaluate, and integrate technologies to reduce weight, provide rapid access, increase environmental protection, reduce

surveillance costs, and increase thermal protection for ammunition items."⁷² Sensor technology as well as efforts in insensitive munitions will provide long-term solutions to survival of ammunition from unplanned stimuli, while reducing the intensive stockpile reliability program man-hours for surveillance. This means more reliable munitions which have better protection and overall reduced life cycle costs.

Munitions distribution velocity enhancement equipment will improve the intermodal munitions distribution system. This system is dependent on the efficiency of cargo transfer at logistics modes.

By increasing munitions distribution velocity through insertion of strategic configured load technologies and commercial efficiencies in transportation MHE, and aircraft cargo delivery sustainment efficiencies in time, cost, and the Army's ability to "push" munitions forward can be realized.⁷³

With smaller stockpiles of critical preferred munitions (i.e. precision guided munitions) air cargo delivery represents the fastest delivery for what amounts to about 19% of the total strategic airlift requirements for DOD for materiel critical to the warfighter. Hence, every efficiency found in streamlining distribution will be a sustainment enabler for the AAN and the DOD.

SOLDIERS

The one resource to ultimately feel the changes in technology, doctrine, organization, training, and leadership is the soldier - "our credentials" as General Reimer stipulates, and "our most precious resource".

The ammunition handler of tomorrow's Army will be faced with many new challenges will be cast across the complete spectrum of war to stability and support operations. "The soldiers today must continue to train hard on technical proficiency in sustainment operations as well as combat survivability on a more modern paced battlefield."⁷⁴ The soldiers must understand and be able to integrate a modular ammunition support concept to best operate on the high-tech digitized battlefield; but have the flexibility to support in a multitude of environments the Army will find itself operating. The best way to achieve this full spectrum of support expertise is to ensure a solid training program that will enhance and sustain wartime skills and knowledge of our new ammunition distribution system. The soldiers will also have to be trained to interface with a larger community of non-military and multinational supporters that require a higher level of integration and synchronization training at every possible event. Likewise, as our distribution system becomes more depot to foxhole in scope, the civilian

ammunition labor force must understand and train better to meet the unique needs of the ammunition personnel on the battlefield.

SUMMARY/RECOMMENDATIONS

The mission to sustain, yet change to meet the challenges of the future is crucial. As we understand, there is much to be done to fully realize the Revolution in Military Logistics (RML) for ammunition support. It is a mission that must be satisfied in virtually all Army eras to include Army of Excellence, Force XXXI, and Army After Next. The capabilities are required now. What is absolutely critical is how in times of decreased operating budget in DOD, how we are to take a logistics system of supply based management and smoothly transfer to a distribution based system. With ground transportation systems critical to maintaining timely and accurate distribution every efficiency must be found in order to revolutionize or support versus a slow evolution of change.

In March 1999, the Munitions Functional Area Assessment laid out a strategic road map for supporting the future warfighter for ammunition. Key objectives outlined the Ammunition Revolution in Military Logistics include; the ability for rapid onload/response; reduce footprint; flexible manufacturing; rapid reconstruction; and a warm industrial base. Under the RML umbrella, major changes must take place now to begin our

transitions to the future. Those changes must be seen in a combination of multiyear production contract and a new life cycle management program that is the result of needed acquisition reform. We must have a best-value approach to our acquisition to streamline the process, re-engineering process to get the best ammunition and technology to the soldier swiftly at reduced costs. We must invest in technology enhancement in weapons survivability and enhanced lethality. Technological innovations in insensitive munitions and precision munitions provide that enhanced capability that keeps our soldiers on the leading edge of technology and survivability on the modern battlefield. The industrial base must change as well to be more efficient and maintain our technological advantage at home. We have seen that the Industrial Base Study briefed to the CSA in December 1998 recommended minimizing government control, establishing a PEO Ammo, commercializing the organic base, and stabilizing the market by ensuring congress approves larger, longer term buys. In doing so, we provide best value logistics at the best price without inhibiting mission execution. It will mean employing best business practices to leverage efficient commercial producers and manufacture munitions without uninterrupted support - a transparent system to the soldier that has ammo going from depot to foxhole without management burdens.

In order to transition from an Army of Excellence through the Force XXI plans, the strategy should be to utilize the recommendations of the Precision Munitions Study (PMS) to produce the right mix of precision versus non-precision munitions based on scenario, time frame, weapon mixes, and cost-benefit analysis to acquire the best mix affordable. In conjunction with this strategy we must recognize the joint and interoperability management standards to produce, when feasible, those munitions that best sustain the way we know we will fight in the future - joint and combined. This process will require not only cooperative acquisition initiatives, but technological optimization and integration with our allies and sister service organizations to come up with more agile/flexible manufacturing base that can retool and produce within acceptable cost parameters.

As we leap ahead to the 21st Century, the AAN will surely see a revolution that is technologically intensive. Munitions must be produced with minimal costs and high return. They will be smart/intelligent with multipurpose capability to support the full spectrum of operators from full up Major Theater War (MTW) to sustain/support contingency operations anywhere on the globe on a moments notice. The new munitions will be even more survivable and more environmentally friendly. Imbedded micro technology will place munitions in a base that is virtual,

integrated, and state of the art in their ability to react to predictive/anticipatory requisitioning requirements of the warfighter. The ability of ammunition to fuse information about itself, the environment, and its relations to where its needed will ensure the right stuff, right place, right qualities, and on time replacement in a peacetime as well as wartime operational scenario.

So just how is it that we get there from here? It has already been said the "the Achilles heel of the Army After Next is not operational or dash speed -- it's logistics."⁷⁵ The road map for the revolution needed is characterized by challenging traditional ways of doing business as we build for the future. There can be no doubt that change will occur. It is also certain that the pace of change in logistics must match or exceed that rate of change in our combat force. This means that change in ammunition support and sustainment must occur simultaneously.

We must continue to refine today's ammunition sustainment, but at the same time work out the RML details from mere concepts to specific action plans. We must have an integrated approach across both DOD and civilian industry with best value business practices at the forefront. It means looking at ammunition sustainment, supply, logistics, and design improvements simultaneously, while focusing on the greatest payoffs. The

payoffs. The greatest payoffs appear to be an approach that focuses on logistics automation, distribution-based supply system and smart business practices to partner with industry while focusing on the greatest payoff. In automation, fused information which is network based with satellite capable communications, is required to provide real-time logistics command and control of automated resources with assured communications. In distribution based sustainment advances in materiel handling, packing, and delivery systems are critical enablers. Contingency based stock piling along with strategic and mission configured loads (SCLs/MCLs) optimized by container and transportation standardization can shorten the time line in the "depot to foxhole" concept. Aided with microchip technology in logistics applications for supply and maintenance of munitions can help logistics planners be more predictive than reactive in their anticipatory logistics support and global direct distribution for requirements. Outsourcing or commercialization of the industrial base would permit a major system change in how we do business without a large infusion of government money. Commercialization is the most economical way to improve the health and vitality of the munitions industrial base. This approach would incentivize producers to invest in flexible production processes. It would allow for full and open competition among qualified producers essential to retaining a

reliable replenishment capability. This acquisition approach is very consistent with the current acquisition reform concepts currently being implemented in the DOD.

CHALLENGES AND OBSTACLES

The changes ahead will certainly meet some obstacles, but they are not insurmountable hurdles to the Revolution in Military Logistics for ammunition support. First, there will always be cultural or institutional resistance. However, it is better to take action now, rather than to let dwindling resources and further cutbacks force unwanted policy and force structure changes later on. Certainly there will be some legislative changes required to ensure laws and regulations are made to optimize change. Concepts as the A76 law for outsourcing, the 60/40 rule for outsourcing contractor support outside US and Canada, and some core logistics would all need review for change. Last, there are some investment costs associated with these changes. Technological advances in weaponry, munitions, sustainment, and distribution/supply need resourcing. The movement of Tier 1 ammunition to best meet SCL load-outs alone may be perceived as cost prohibited, yet the readiness, payoffs and reduced logistics footprint may outweigh the outlay of capital required to make it happen.

IMPLEMENTATION

The implementation of this new Revolution of Military Logistics for Ammunition will require strong leadership and management commitment to succeed. The first step of implementation is to obtain the firm commitment of Army senior leadership. The CSA has recently (December 1998) made that commitment making the Deputy Chief of Staff for Ammunition the executive agent for change to begin implementation. This implementation takes on a dramatically different way of looking at the munitions business. It involves new initiatives for doctrine, organizational structures, training, leadership development, materiel, and soldiers. Although the concepts embodied in this paper have been successfully applied in other Army mission areas, they represent a major change for the munitions community. Implementation will be a major challenge. The amount of change required to start now, is great, even though it uses proven concepts. Solid change management is required for success. Because so many aspects of what was covered in this strategic research paper reinforce each other, a partial implementation will lead to poor results.

The recommendations seen here places management responsibility, authority, and accountability in a unified management structure that must be totally integrated in its approach to taking action. The primary risks seen in the

ammunition community today have actually resulted from not taking decisive action in the past. The Army Vision 2010 states:

...Focused logistics will be the future of logistics, and information technologies, flexible and agile combat service support organizations, and new doctrinal support concepts to provide rapid crises response to deliver precisely tailored logistics packages directly at each level of military operations.⁷⁶

Ammunition support is considered crucial in fully realizing the Revolution in Military Logistics. "The ammunition community's primary goal is to provide premier ammunition support to enable soldiers to fight effectively and survive on the battlefield."⁷⁷ This is a mission that must be satisfied in virtually all Army eras to include Army of Excellence, Force XXI, and Army After Next. It is a mission that requires decisive action now to arm the Army of the 21st Century.

[word count :14,078]

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